array and to align the color components of light along distinct, telecentric, non-diverging paths that are normal to the plane of the imaging device.

12. (Twice Amended) In an optical system having a focusing element for focusing separated color components of light to plural distinct regions of an imaging plane of an electronic imaging device with an array of pixel apertures, the improvement comprising:

a diffractive color dispersing layer positioned between the focusing element and the imaging plane for aligning the color components of light along distinct, telecentric, non-diverging paths that are normal to the imaging plane at the pixel apertures.

20. (Twice Amended) A telecentric color filtering method for providing telecentric color-filtered light to an imaging plane of an electronic imaging device, comprising:

forming plural diverging color light components;

directing the plural diverging color light components through a focusing element positioned before a holographic grating; and

directing the plural diverging color light components through the holographic grating to align the color light components along distinct, non-diverging paths that are telecentric with respect to the imaging plane so that all the color light components are normal to the imaging plane.

Remarks

Claims 1, 4-20, and 22-24 are in the application. Claims 1, 12, and 20 are in independent form. Reconsideration is requested.

Claims 1, 2, 4-20, and 22-24 stand rejected under 35 U S.C. 103(a) for obviousness over Nakanishi et al. (US Pat. No. 5,760,850). Claim 2 has been cancelled.

With regard to claim 1 the Examiner states that Nakanishi et al. discloses a color display system with a holographic grating (Fig. 6, holographic elements 7, 8; Fig. 7, holographic element 12) that receives the color components of light

from the refractive lens array for aligning the color components of light along distinct, non-diverging paths (See col. 11, lines. 56-61; also see principal rays: col. 12, lns. 53-59). The Examiner adds that it would have been obvious to provide "the display optical system of Nakanishi et al. with an imaging device (e.g., a CCD detector/imager) having an array of pixels with pixel apertures with which said holographic grating aligns said color components of light along distinct, non-diverging paths." The Examiner asserts that "such imaging devices being notoriously old and well-known in the imaging art, for at least the purpose of allowing one to, for the sake of example, determine the integrity of said display optical system prior to its being sold." Applicant responds as follows.

Amended claim 1 clarifies that the holographic grating is positioned between the refractive lens and the imaging device. As shown in Fig. 1, for example, holographic grating 22 is positioned between lens array 18 and LCD 20. As recited in the claim, the holographic grating receives the color components of light <u>from the refractive lens array</u> and aligns them along distinct, telecentric, non-diverging paths that are normal to the plane of the imaging device. This positioning of the holographic gating and formation of telecentric light is shown in Figs. 1, 6, 7, and 12.

Applicant notes that Nakanishi et al. only describes holographic elements as being positioned <u>after</u> the liquid crystal display. As shown in Figs. 2 and 6 of Nakanishi et al., holographic elements 7, 8 are positioned <u>after</u> LCD element 6 and <u>not between</u> microlens array 5 and LCD element 6. Likewise, Fig. 7 of Nakanishi et al. shows a holographic element 12 positioned <u>after</u> LCD element 6 and <u>not between</u> microlens array 5 and LCD element 6.

Nakanishi et al. does not teach or suggest a holographic element that is positioned between a lens array and the LCD. Rather, Nakanishi et al. shows a holographic element as positioned anywhere BUT between a lens array and the LCD. In addition, Nakanishi et al. only shows the color components of light being directed through the pixels of the liquid crystal display along diverging, non-telecentric paths, as shown in Figs. 2, 6, 7, 9, and 13A. Figs. 1, 8, and 13B of

Nakanishi et al. are enlarged representations that do not show the light path details of respective Figs. 1, 9, and 13A.

The positioning of the holographic grating recited in claim 1 provides telecentric, non-diverging paths that are normal to the plane of the imaging device (e.g., LCD 20, application Fig. 1). The telecentric, non-diverging paths of claim 1 are distinct from and provide clear benefits over the non-telecentric, diverging light paths at the pixels of the imaging device of Nakanishi et al, as shown in Figs. 2, 6, 7, 9, and 13A.

For example, liquid crystal displays commonly have display contrasts that are dependent on the angles at which light pass through the displays. The telecentric, non-diverging paths provided by the positioning of the holographic grating according to the present invention provide uniform light angles and image contrasts for all color components. In contradistinction, Nakanishi et al. provides different angles for different color components, as shown in Figs. 6 and 9 for example. These different angles for different color components can result in varying contrasts for the different color components, which can significantly degrade image quality.

In addition, different angles for different color components can result in different amounts of light being transmitted for different color components. For example, color components of light at some angles can be misaligned with pixel apertures, resulting in either light leakage under a shielding (blocking) surface or blockage of light by the shielding (blocking) surface.

Furthermore, Fig. 7 of Nakanishi et al. illustrates another difficulty with positioning holographic element 12 after liquid crystal display 6, namely, that the diverging color components after the liquid crystal display results in variable and undesirable overlap of color components. The diffraction of the principal rays illustrated in Fig. 7 is inadequate to compensate for the wide variety of angles and lateral displacements of the various rays for each color component.

The telecentric, non-diverging paths that are normal to the plane of the imaging device, as provided by the positioning of the holographic grating recited

in claim 1, are distinct from and provide clear benefits over the image display apparatus of Nakanishi et al. The Examiner states that it would have been obvious to provide "the display optical system of Nakanishi et al. with an imaging device (e.g., a CCD detector/imager) having an array of pixels with pixel apertures with which said holographic grating aligns said color components of light along distinct, non-diverging paths." Applicant submits that Nakanishi et al. positions a holographic element only <u>after</u> a liquid crystal display. Nakanishi et al. provides no teaching or suggestion to position a holographic element <u>between</u> a lens array and an imaging device, as recited in claim 1. Applicant submits therefore, that Nakanishi et al. would lead one skilled in the art away from positioning a holographic element between a lens array and an imaging device.

Applicant believes claims 4-11 are allowable as depending from claim 1. In addition, applicant submits that various o these dependent claims are further patentable for the following reasons.

Claim 4 recites that the lens array includes an array of cylindrical lenses. The Examiner cites Fig. 7 of Nakanishi as showing an array of cylindrical lenses in cross section. Applicant submits that such an interpretation of Fig. 7 is not supported by, and is inconsistent with, the description of microlens arrays in Nakanishi.

Fig. 3 of Nakanishi shows hexagonal microlenses 5 that have the same reference numeral as the microlenses of Fig. 7 cited by the Examiner. Such a hexagonal shape bears no resemblance to, and provides no support for, the cylindrical lenses recited in claim 4. Rather, the hexagonal microlenses 5 of Nakanishi et al. would lead one skilled in the art away from the cylindrical lenses recited in claim 4. Applicant submits that the rejection of claim 4 is based upon an incorrect statement of the teaching of Nakanishi et al. Applicant requests, therefore, that the rejection of claim 4 be withdrawn.

With regard to claim 5 the Examiner states that "optical power refers exclusively to refractive, as opposed to diffractive, effects." Claim is apparently rejected based upon the reasoning that if "optical power refers exclusively to

refractive" effects, then the holographic elements of Nakanishi must not have optical power.

Applicant notes, however, that optical power may be imparted refractively, reflectively, and diffractively. Curved mirrors are commonly used to impart optical power, as in telescopes. The commonality of diffractive optical power is supported simply a search of the Patent Office database, which returns 338 patents as using the term "holographic lens." Applicant submits, therefore, that optical power can be imparted diffractively and that Nakanishi provides no teaching or suggestion of a holographic grating "without optical power."

Applicant has cited examples illustrating that optical power can be imparted refractively, reflectively, and diffractively. The Examiner provides no support for the statement that "optical power refers exclusively to refractive, as opposed to diffractive, effects." Pursuant to MPEP 2144.03, applicant requests that the Examiner provide documentary evidence to support the quoted statement or withdraw the rejection of claim 5 for lack of support.

Amended independent claim 12 recites an optical system having a focusing element for focusing separated color components of light to plural distinct regions of an imaging plane with an array of pixel apertures in an electronic imaging device. A diffractive color dispersing layer is positioned between the focusing element and the imaging plane for aligning the color components of light along distinct, non-diverging paths, the imaging plane including an array of pixel apertures of an electronic imaging device.

In the rejection of claim 5, the Examiner states that "Nakanishi et al. teach said focusing element (Fig. 7, focusing element 5), and said diffractive color dispersing layer (holographic optical element 7 in Fig. 7) positioned between the focusing element and the imaging plane." Applicant submits that Nakanishi et al. makes no teaching or suggestion of a holographic element positioned between a focusing element, such as a lens array, and an imaging plane of an electronic imaging device with an array of pixel apertures. Instead, Nakanishi et al. shows a holographic element positioned anywhere but between a microlens array and

an LCD. In Figs. 1, 2, 6, 7, and 13A, Nakanishi et al. shows holographic elements positioned after the LCD. In Figs. 8, 9, 13A, 14, 15, and 18, Nakanishi et al. shows holographic elements positioned in front of the microlens array.

Applicant submits, therefore, that Nakanishi et al does not teach or suggest the subject matter of claim 12. Moreover, Nakanishi et al. does not teach or suggest the benefits of the arrangement of claim 12, as described above with reference to claim 1. Applicant requests, therefore, that the rejection of claim 12 be withdrawn.

Applicant submits that claims 13-19 are patentable as being dependent on patentably distinct claim 12. Applicant believes dependent claims 14 and 17 are further patentable for the reasons set forth above with reference to claims 4 and 5, respectively.

Claim 20 recites a telecentric color filtering method for providing telecentric color-filtered light to an imaging plane of an electronic imaging device so that all the color light components are normal to the imaging plane. The method includes forming plural diverging color light components, directing the plural diverging color light components through a focusing element positioned <u>before</u> a holographic grating, and then directing the plural diverging color light components through the holographic grating to align the color light components along distinct, non-diverging paths that are telecentric with respect to the imaging plane of an electronic imaging device. Applicant submits that claim 20 is patentably distinct from the cited reference for the following reasons.

The Examiner states that Nakanishi et al. teaches "a telecentric color filtering method for providing telecentric color-filtered light to an imaging plane." Applicants note, however, that Nakanishi et al. provides to teaching or suggestion of providing telecentric light at the imaging plane <u>of an electronic imaging device</u>. Nakanishi et al. only shows the color components of light being directed through the pixels of the liquid crystal display along diverging, non-telecentric paths, as shown in Figs. 2, 6, 7, 9, and 13A. Nakanishi describes a projection type image display apparatus with holographic elements positioned

after a liquid crystal display element (Figs. 1, 2, 6, 7), or before a microlens array (Figs. 8, 9, 14, 15, 18, 21), or both (Figs. 13A, 13B). In contrast, claim 20 recites a filtering method in which a holographic grating is positioned between a refractive lens array and an electronic imaging device.

Applicant submits that Nakanishi provides no teaching or suggestion of a filtering method that employs the sequence of optical steps recited in claim 20. Nakanishi is directed to reducing aperture size of the projection optics and so is directed to positioning holographic elements before the microlens array or after the LCD. Nakanishi et al. discloses no structure or arrangement positioned between the microlens array and the imaging device to counter-diverge the color channels exiting the microlens. Instead, Nakanishi is directed to reducing the projection lens aperture rather than providing parallel chief rays at the pixel apertures. Applicant requests, therefore, that claim 20 be allowed.

Applicant submits that claims 22-24 are patentable as being dependent on patentably distinct claim 20. Applicant believes dependent claims are further patentable for the following reasons.

Applicant believes the application is in condition for allowance and respectfully requests the same.

IPSOLON LLP
805 SW BROADWAY #2740
PORTLAND, OREGON 97205
TEL. (503) 249-7066
FAX (503) 249-7068

Respectfully Submitted,

Mark M. Meininger
Registration No. 32,428

Attachment
Claims 1, 4-20, and 22-24
Application Number: 09/681,185

1. (Twice Amended) A color display optical system, comprising:

a refractive lens array for receiving and focusing diverging color components of light;

[a holographic grating receiving the color components of light from the refractive lens array for aligning the color components of light along distinct, non-diverging paths; and]

an imaging device [having] <u>that defines a plane with</u> an array of pixels with pixel apertures [with which the holographic grating aligns the color components of light along distinct, non-diverging paths]<u>; and</u>

<u>a holographic grating positioned between the refractive lens and the imaging device to receive the color components of light from the refractive lens array and to align the color components of light along distinct, telecentric, non-diverging paths that are normal to the plane of the imaging device</u>.

4. The system of claim 1 in which the lens array includes an array of cylindrical lenses.

5. The system of claim 1 in which the holographic grating is continuous and without optical power.

6. The system of claim 1 in which the holographic grating includes a volume hologram.

7. The system of claim 1 further comprising a color divergence element that provides the diverging color components of light to the refractive lens array.

8. The system of claim 7 in which the color divergence element includes plural angularly inclined dichroic mirrors for providing color separation of incident multi-color illumination light.

9. The system of claim 7 in which the color divergence element includes a holographic grating for providing color separation of incident multi-color illumination light.

10. The system of claim 9 in which the holographic grating of the color divergence element is substantially the same as the holographic grating for aligning the color components of light.

11. The system of claim 1 in which the holographic grating delivers the distinct color components of light to a selected plane and is positioned substantially midway between the selected plane and the lens array.

12. (Twice Amended) In an optical system having a focusing element for focusing separated color components of light to plural distinct regions of an imaging plane of an electronic imaging device with an array of pixel apertures, the improvement comprising:

a diffractive color dispersing layer positioned between the focusing element and the imaging plane for aligning the color components of light along distinct, telecentric, non-diverging paths[, the imaging plane including an array of pixel apertures of an electronic imaging device] that are normal to the imaging plane at the pixel apertures.

13. The system of claim 12 in which the focusing element includes a microlens array.

14. The system of claim 13 in which the microlens array includes plural cylindrical lenses.

15. The system of claim 12 in which the diffractive color dispersing layer aligns the color components of light to be normal to the imaging plane.

16. The system of claim 12 in which the diffractive color dispersing layer includes a volumetric hologram.

17. The system of claim 16 in which the diffractive color dispersing layer is isotropic and without optical power.

18. The system of claim 12 in which the imaging plane is a transmissive type electronic display panel with pixel apertures in a stripe formation.

19. The system of claim 12 further comprising a color divergence element that provides diverging color components of light to the focusing element.

20. (Twice Amended) A telecentric color filtering method for providing telecentric color-filtered light to an imaging plane of an electronic imaging device, comprising:

forming plural diverging color light components;

directing the plural diverging color light components through a focusing element positioned before a holographic grating; and

directing the plural diverging color light components through the holographic grating to align the color light components along distinct, non-diverging paths that are telecentric with respect to the imaging plane <u>so that all the color light components are normal to the imaging plane</u>.

22. The method of claim 20 in which the focusing element includes a lens array.

23. The method of claim 20 in which forming the plural diverging color light components includes directing multi-color illumination light toward plural angularly inclined dichroic mirrors that provide color separation of the incident multi-color illumination light.

24. The method of claim 20 in which forming the plural diverging color light components includes directing multi-color illumination light through a holographic grating for providing color separation of incident multi-color illumination light.